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REVIEW ARTICLE

Prophylactic and Therapeutic Use of Antibiotics in Pelvic Surgery

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The abiding principles of antibiotic use in the surgical patient vary in the complicated pelvic surgery setting only in that some microbes likely to be encountered warrant minor variation in drug choice. Very early antibiotic administration, relatively large doses, and prompt association when the reason for therapy has been accomplished, are the keystones for treatment. Tissue levels of antimicrobial activity are the uniform therapeutic goal. We also prefer consistent selection of drugs known to be safe and believe that continuous infusion may enhance the overall protective effect. Preservation of normal host defenses enhances the action of all antibiotics.
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INTRODUCTION

The preventive use of systemic antibiotics, or surgical prophylaxis, is defined as the "administration of antimicrobial drugs during surgery to patients without evidence of established infection in anticipation of preventing infection" [1]. The value of systemic antibiotic prophylaxis in reducing postoperative wound and surgical site infection has been well established over the past 30 years and is based upon several basic principles:

1. The need for prophylaxis depends upon the risk of infection associated with a procedure and is weighed against the possible detrimental effect from antibiotic use.
2. The antimicrobial agent chosen should be safe and have an antimicrobial spectrum reasonably appropriate for the organisms expected to be encountered during the operative procedure.
3. The antimicrobial agent of choice should be administered preoperatively before the period of contamination and should have therapeutic activity within the wound for the duration of the contamination period.
4. The antimicrobial agent of choice should be administered for the shortest period of time perioperatively as is necessary to provide a protective benefit.

Operative procedures are classified on the degree of contamination of the operative site. Clean procedures are those in which aseptic techniques have been maintained throughout the duration of the case, and no mucosal surface has been entered. These wounds are closed primarily and generally carry a 1–3% rate of wound infection. Prophylactic antibiotics are not generally indicated in these procedures unless the consequences of infection would be catastrophic (i.e., procedures in which prosthetic material or devices are placed). Clean-contaminated procedures are defined as operations in which a mucosal surface has been entered; however, spillage is minimal. Infection rates after clean-contaminated cases are generally 10–20%. The greatest benefit for antibiotic prophylaxis is observed in these cases, because, at this point, the risk of the development of infection substantially outweighs the risk of a potential adverse event from antibiotic use. The use of antibiotics for contaminated and dirty procedures should be considered treatment of early or established infection, even though, by definition, antibiotic therapy follows contamination or established infection.

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TABLE I. Recommendations for Antibiotic Prophylaxis for Common Pelvic Procedures

Type of operative procedures	Bacteria encountered	Antimicrobial agent
Intraperitoneal colorectal	Enteric aerobes and anaerobes	Cefotetan or cefoxitin
Extraperitoneal colorectal	Enteric aerobes and anaerobes	Oral neomycin/erythromycin plus cefotetan or cefoxitin
Gynecologic	Enteric aerobes and anaerobes, E. fecalis, group B streptococci	Cefazolin

The antimicrobial agent used for prophylaxis should be effective against the pathogens most likely to cause infection and based on the site of operation. Table I outlines recommendations for our drug selections for surgical prophylaxis for common procedures in the pelvis. In addition, the spectrum of activity of the agent should be relatively limited to these organisms. The use of very broad spectrum regimens for prophylaxis increases the emergence of resistant organisms within the individual patient, which can then be conferred to other patients directly or indirectly through the environment or through health-care personnel. This, in turn, may lead to personal risk and ecologic costs that are difficult to quantitate in financial terms [2,3].

Perhaps the most important principle of antibiotic prophylaxis is the choice of an agent that is safe. Table II lists toxicities of antibiotics commonly used for prophylaxis. In general, the cephalosporins and penicillins have, over time, proven to be safe and, at the same time, to be effective for prophylaxis. The majority of their toxicities resolve upon cessation of the drug, and the most dreaded of their toxicities—and anaphylactic reaction—can usually be avoided by obtaining a careful history. The aminoglycosides, on the other hand, represent a class of antibiotics in which renal and otic toxicities often are irreversible and, in our opinion, preclude their routine use as prophylactic agents.

The timing of antibiotic administration is crucial, since the effectiveness of systemic antibiotic prophylaxis is related to the presence of the drug in the tissues in adequate concentrations and to the bacteria exposed to those tissues. Most investigators agree that this equates to the time of initial incision. Parenteral antibiotics should be administered 20–30 minutes prior to incision, depending upon the pharmacokinetic properties of the given drug. Administration too soon may lead to the prevalence of resistant organisms, whereas administration too late leads to increased rates of infection [4]. Wound tissue levels are responsible for the ability of systemic antibiotics to decrease infection rates perioperatively [5]. For this reason, during procedures that are lengthy and those involving substantial blood loss, the drug should be readministered at each drug half-life interval to maintain drug levels above the minimum inhibitory concentration. Recent studies provide evidence that very large prophylactic doses of antibiotics may decrease the rate of postoperative infection, especially when hemorrhage and/or hypotension is likely to be encountered [6].

Finally, antibiotic prophylaxis should be continued for the shortest time of proven efficacy. This minimizes cost, toxicity, and emergence of resistance. Traditional recommendations suggest continuation of antibiotics for 24–48 hours postoperatively, but recent studies suggest that such coverage beyond the operating room is unnecessary, unless prosthetic materials are used [1].

ANTIBIOTICS IN PELVIC SURGERY

Prophylactic Role

Bacterial contamination and subsequent infection during pelvic surgery can occur from multiple sources. These sources include the urinary tract, the genital tract—especially the female genital tract—and the alimentary tract. If any of these cavities are entered during the course of an operative procedure, significant postoperative infectious morbidity can result. For this reason, systemic prophylactic antibiotics are indicated in certain situations during urologic surgery, during specific procedures on the female genital tract, and always for procedures involving the colon and the rectum.

The urinary tract in the healthy, unobstructed, and uncatheterized state is bacteriologically sterile. When urinary tract infection is diagnosed preoperatively, every attempt is made to sterilize the urine before surgery (see Preoperative Problems). It has been shown that patients with positive results on urine bacterial cultures at the time of prostatic surgery receive some benefit from systemic antimicrobial therapy directed at the organisms likely to be present [7]. These organisms are usually of gram-negative enteric etiology and are adequately covered by perioperative doses of several drugs.

The vagina has bacterial counts that approach 1×10^8 to 1×10^9 organisms/ml. These bacterial species normally include gram-positive aerobic cocci, gram-negative enteric bacteria, as well as anaerobic bacilli and anaerobic streptococci. Anaerobes are numerically dominant, approaching ratios of 10:1. When the vagina is entered during operative procedures, these organisms gain access to the pelvis. Antibiotic prophylaxis is recommended for vaginal hysterectomy, especially in younger women. However, the value of prophylaxis in abdominal hysterectomy is controversial and, in general, is reserved for patients with a high risk of pelvic or abdominal wound infection [8,9]. Perioperative doses of a first- or second-generation cephalosporin are effective in these cases, and no added benefit seems to have been

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shown with the use of extended-spectrum cephalosporins.

The early research on surgical antibiotic prophylaxis was based upon studies examining operations on the alimentary tract. Because of the high concentration of aerobic (1×10^9 organisms/g of feces) and anaerobic (1×10^{11} organisms/g of feces) pathogens in the colon and rectum, operative procedures have long been associated with a high incidence of infectious complications. Rates of infection as high as 30–50% have been reported in the absence of prophylaxis. Attempts at decreasing these rates by decreasing the stool bulk and luminal bacterial content through mechanical bowel preparation have long been practiced; indeed, this is a routine part of preoperative preparation in colorectal surgery currently. However, it has been shown that the concentration of organisms in the remaining fluid after mechanical preparation is unchanged. Other attempts have focused on decreasing these rates of infection by decreasing the intraluminal concentration of bacteria through the administration of preoperative oral antibiotics. Several studies have shown a prophylactic benefit with oral preoperative antibiotics. However, this has never been definitively proven to be superior to perioperative systemic antibiotics. Combinations of oral and systemic drugs are of most clear-cut value in low anterior resections of the upper rectum [10].

The initial studies regarding the benefit of systemic antibiotic prophylaxis in colorectal surgery were flawed by inconsistencies in antibiotic administration and choice and by comparison of dissimilar groups and therapies. The definitive clinical study on surgical antibiotic prophylaxis in 1969 [11] showed a statistically significant decrease in the infection rate in patients receiving prophylactic parenteral antibiotics for elective procedures on the alimentary tract. These results have been reliably reproduced, but the current recommendations for systemic prophylaxis involve the use of an agent with a spectrum of activity against gram-positive aerobes as well as gram-negative aerobes and anaerobes. Perioperative doses of second-generation cephalosporin agents (cefoxitin, cefotetan) are effective agents for this purpose.

Therapeutic Role

The development of infection after surgical procedures, and, in general, is based upon the interaction of a number of factors: (1) the size and virulence of the bacterial inoculum; (2) the presence of nutrient media on which microbes can thrive (e.g., hematomas); (3) the presence of alterations in local and systemic host resistance limiting the body's capacity to combat invasive infection. The relative importance of each of these factors in the development of a given infection varies, but any combination of the foregoing may lead to virulent infection.

Infection is diagnosed on the basis of the clinical signs of acute inflammation (rubor, calor, tumor, dolor)

TABLE III. Therapeutic Protocols Effective Against Commonly Encountered Pelvic Infections

Single-agent therapy
Second-generation cephalosporin
Cefotetan
Cefoxitin
Carbapenem
Imipenem
Combination therapy (one of the following plus metronidazole)
Third-generation cephalosporin
Cefotaxime
Ceftriaxone
Monobactam
Aztreonam
Aminoglycoside
Tobramycin
Gentamicin

TABLE IV. Pathogens Commonly Encountered in Community-Acquired and Nosocomial Urinary Infections

Community-acquired	Nosocomial
Escherichia coli	*Escherichia coli*
Proteus species	*Klebsiella* species
Klebsiella species	*Pseudomonas* species
Enterobacter species	*Proteus* species
Staphylococcus species	*Enterobacter* species
	Enterococcus species

coupled with the presence or absence of systemic signs of infection (fever, leukocytosis). Once diagnosed, collections of pus that may be present are drained, and nonviable tissue is debrided. Systemic antibiotics are initiated when there are local (cellulitis) or systemic signs of invasive infection. Antibiotics are no longer considered prophylactic at this point but instead are therapeutic. As in prophylaxis, the agent chosen should have a spectrum of activity that covers the pathogens likely to be responsible for infection. Our personal choice is to give larger doses for shorter periods. Definitive therapy should be guided by the results of cultures and sensitivities and should be continued for a minimum of 3–5 days. Therapy should be discontinued when signs of active infection (fever, leukocytosis) have resolved. The apparent need to continue antibiotics beyond a course of 10 days should raise questions concerning the appropriateness of the antibiotic's spectrum, the evolution of resistance in the pathogen, the failure of the antibiotic to penetrate the site of infection, or the need for surgical drainage or debridement. Table III lists therapeutic protocols effective against commonly encountered pelvic infections.

Preoperative Problems

Urinary tract infections. Urinary tract infection (UTI) is considered to be the most common site of nosocomial infection, accounting for 30–40% of all hospital-acquired infections, and the frequency of bacteriuria and UTI increases with age. When infected urine is present at the time of instrumentation or other procedures involving the urinary tract, the risk of postoperative infection is increased. Any patients undergoing pelvic surgery should be evaluated preoperatively by urinalysis with culture and sensitivity. The presence of $\geq 1 \times 10^5$ bacteria/ml of urine in a patient without an indwelling urethral catheter or $\geq 1 \times 10^2$ bacteria/ml of urine in patients with an indwelling catheter is indicative of infection. Attempts should be made to sterilize the urine preoperatively with antibiotics. Common pathogens for both community-acquired (non–catheter-related) and nosocomial (catheter-related) UTIs are listed in Table IV. Ideally, urinalysis should be performed several days preoperatively to allow for adequate treatment with reassessment of therapeutic effectiveness via repeat urinalysis prior to surgery.

The definitive antimicrobial therapy for UTI should be determined on the basis of culture and sensitivity testing. Empiric therapy for UTI should be based upon likely pathogens. For the noncritically ill, nonbacteremic patient, oral therapy with trimethoprim-sulfamethoxazole or a quinolone is appropriate. In the severely ill patient with possible bacteremia, intravenous therapy with a quinolone or the combination of a third-generation cephalosporin (cefotaxime) and an aminopenicillin (piperacillin) is appropriate empiric therapy. Short courses of antibiotics (2–3 days) are appropriate for uncomplicated UTIs [12]. Some studies advocate the use of single-dose therapy [13,14]; however, there is a reluctance toward this due to the concern of failure in high-risk patients and the subsequent development of complications when the infection is not eradicated. Longer courses of therapy should be used only in complicated upper tract infections. Continuing drainage (i.e., Foley catheter) is more often than not an asset in the management of severe urinary infection.

Gynecologic infections. As previously stated, the natural flora of the lower female reproductive tract is heavily laden with gram-negative, gram-positive, and anaerobic bacteria. These organisms are responsible for postoperative infection after gynecologic procedures, and it is toward these pathogens that perioperative antibiotics during gynecologic procedures should be directed. When established infections of the lower female genital tract are present preoperatively, attempts should be made to eradicate these in order to reduce postoperative infectious complications. Table V lists common lower female genital tract infections and their treatment.

Gynecologic tumors represent a special situation and deserve special consideration. Patients with gynecologic malignancies have long been recognized to be at high risk for the development of infections and occasionally present with infected tumors. This increased susceptibility to infection, usually with resistant organisms, is believed to be a consequence of several factors: (1) the generalized immunosuppressed state induced by the disease process and/or by the treatment of the malignancy

TABLE V. Therapeutic Protocols for Commonly Encountered Lower Female Genital Tract Infections

Infection type	Agent	Dosage[a]
Monilial vulvovaginitis	Miconazole	100 mg vaginal supp qhs × 7 days
Trichomonas	Metronidazole	2 g orally in a single dose
Bacterial vaginosis	Metronidazole	500 mg po bid × 7 days
Chlamydia	Doxycycline	100 mg po bid × 7 days
Gonorrhea	Ceftriaxone	250 mg IM once followed by doxycycline 100 mg po bid × 7 days

[a]po, by mouth; bid, twice daily; IM, intramuscularly; supp, suppository; qhs, at bedtime.

with radiation therapy or chemotherapy; (2) surgical procedures in these patients are frequently of extended duration and may involve multiple contamination sites (i.e., urinary and gastrointestinal tract from fistulization); (3) cancer patients frequently undergo multiple hospitalizations and are exposed to antibiotic-resistant organisms. For these reasons, such patients should be administered broad-spectrum antibiotics perioperatively. If active infection is present preoperatively, antibiotics should be initiated preoperatively and continued postoperatively. Patients who present with pyometra should undergo drainage as well as a course of antibiotics preoperatively.

Alimentary tract problems. Systemic antibiotics are required for patients in whom there has been peritoneal fecal contamination from colorectal injury. This injury may be either post-traumatic or secondary to intrinsic colonic disease processes such as perforative diverticulitis or colon cancer. Systemic antibiotics in these instances are therapeutic but are not necessarily definitive therapy. Definitive therapy in these instances involves operating to cease peritoneal soiling. Antibiotics play a secondary but nonetheless important role in these cases.

The choice of antibiotics for these situations includes agents effective against gram-positive aerobes as well as gram-negative aerobes and anaerobes. For infections of mild to moderate severity, single-agent therapy with a second-generation cephalosporin (cefoxitin, cefotetan) or extended-spectrum penicillin (ticarcillin-clavulanate) can be used. For more serious infections, single-agent therapy with a carbapenem (imipenem-cilastatin) or combination therapy with either a third-generation cephalosporin (cefotaxime), a monobactam (aztreonam), or aminoglycoside (tobramycin) plus an antianaerobe (metronidazole) is recommended [15]. Again, it should be stressed that the antibiotic spectrum should be narrowed on the basis of the results of appropriate cultures and sensitivities.

Postoperative Problems

Fever. Fever in the postoperative patient is a very common occurrence, but it is beyond the scope of this paper to discuss the myriad possible causes of postoperative fever. In general, however, fever within the first 24–48 hours after surgery is usually noninfectious and secondary to atelectasis. An early wound infection or pneumonia can present during this period. A clinical examination should be performed, including a thorough examination of the chest, wound, and all intravenous sites. Further workup should be based upon the clinical examination, and a "shotgun" approach should not be taken. Fever developing 72 hours or more after operation usually suggests the presence of an infection.

Postoperative urinary infection. Urinary tract infections are said to account for 27% of all postoperative infections and are the second most common infection in surgical patients [16]. Over 90% of postoperative UTIs are a result of urethral catheterization. The prevention of catheter-associated UTI requires an aseptic technique during catheter placement, the maintenance of a closed drainage system, and the removal of the catheter promptly after its purpose has been served. Systemic antibiotic prophylaxis to reduce catheter-associated UTI has been advocated but can lead to the emergence of infection with resistant organisms [17].

The development of bacteriuria after urethral catheterization is a common event, making the diagnosis of true UTI somewhat difficult. Between 70% and 80% of patients with catheter-associated bacteriuria are asymptomatic. In the postoperative patient who develops systemic symptoms of fever and leukocytosis and is found on urinalysis to have bacteriuria, with or without pyuria, rarely are these symptoms attributable to UTI. This is especially true in the patient with an indwelling catheter at the time of onset of systemic symptoms. Another source of infection should be sought in these and all other patients with post-catheterization bacteriuria.

In patients whose UTI has been confirmed by culture results, antibiotics directed at the responsible organism should be initiated, while keeping in mind that catheter-associated UTIs are due to multiresistant organisms. There is some evidence to suggest that an infected urinary tract, as evidenced by a positive urine culture, may not require antibiotics for clearance of infection in the presence of continuous drainage by an indwelling catheter. Certainly in patients with obstructive uropathy in whom UTI develops after catheter removal, clearance of infection cannot be accomplished without bladder drainage by a catheter.

Surgical site infections. Surgical site infections usually manifest 5 to 10 days after operation and can be divided into incisional or organ-space infections. Incisional surgical site infections involve the wound down to the level of the fascia and may be further classified as superficial or deep. Organ-space infections involve the body cavity deep to the fascia. As discussed earlier, the likelihood of an infection developing within the surgical site is related to the degree of contamination encountered at the time of surgery.

Superficial incisional infections usually present with the characteristic signs of acute inflammation—rubor (erythema), calor (warmth), tumor (edema), dolor (pain)—with or without purulent drainage. Crepitus found on physical examination may signify the presence of a necrotizing infection secondary to gas-producing organisms. Fever and leukocytosis may be present. Because of their location, deep incisional infections may not present with local signs and symptoms, leading to delayed diagnosis.

The primary tenet behind management of surgical site infections is that of drainage of purulent collections. Drainage is of first and foremost importance and usually all that is needed for most incisional infections. Sutures should be removed and the wound opened over the extent of the infection with inspection for fascial integrity. Specimens for Gram's stain and culture should be obtained, and the wound should be treated with wet-to-dry dressings of fine mesh gauze. Antibiotics should be employed as an adjunct to drainage if local (cellulitis) or systemic (fever and leukocytosis) signs of infection are present. Empiric antibiotic choice should be based on the most likely organisms to be encountered as wound pathogens or on the results of the Gram's stain of purulent wound drainage.

Incisional infections after pelvic surgery are frequently polymicrobial, involving gram-negative aerobes and anaerobes. Early-onset incisional infections (< 48 hours after surgery) are usually secondary to group A streptococci, *Clostridium perfringens*, or group B streptococci. These infections may be necrotizing in nature, causing profound systemic illness. Prompt surgical debridement of all nonviable tissue and institution of systemic therapy with intravenous penicillin are indicated. Late-onset (postoperative days 4–7) incisional infections are most commonly caused by *Staphylococcus* species, *Streptococcus* species, gram-negative enteric organisms, or anaerobes. Patients should rapidly improve after simple drainage of these infections; however, if fever or cellulitis persists, systemic antibiotic therapy with an agent effective against enteric gram-negatives and anaerobes (cefoxitin, cefotetan) should be instituted. Failure to respond to antibiotic therapy should raise the questions of the need for further debridement, the presence of other sources of infection, or the coexistence of an intra-abdominal or pelvic abscess.

Organ-space infections involving the peritoneal cavity or the pelvis are frequently polymicrobial in etiology also, and their diagnosis can be quite difficult. Physical examination is usually compromised by the presence of pain from the abdominal incision. Palpable masses and localized tenderness may or may not be present. Persistent or recurrent fever and leukocytosis may be misleading because of the presence of other sources of infection in the surgical patient. The presence of prolonged or recurrent ileus in the postoperative patient can also allude to the existence of an intra-abdominal or pelvic abscess.

The radiographic diagnosis of organ-space infections by plain roentgenograms is notoriously unreliable. Ultrasound has been a popular method of diagnosis of intra-abdominal and pelvic abscesses and has the advantage of being inexpensive but is limited by poor anatomic detail in the presence of large amounts of intestinal gas. Computed tomography has become the diagnostic method of choice, with a greater than 90% accuracy at diagnosing the presence of abscesses and has the advantage of allowing percutaneous drainage.

As in incisional infections, drainage is the primary treatment of intra-abdominal and pelvic abscesses. Drainage may be either percutaneous or operative and should be dependent if possible. Palpable cul-de-sac pelvic abscesses may be drained transrectally. Patients with severe physiologic embarrassment from the septic process, especially those with associated organ failure, should undergo re-exploration with extensive surgical drainage and debridement. Abscess secondary to an anastomotic leak should be treated with drainage and proximal diversion to prevent continued fecal contamination. Even though antibiotics have a secondary role, they should be initiated at the time of diagnosis and should be continued during and after drainage. The polymicrobial nature of these infections warrants the use of antibiotics effective against gram-negative enteric aerobes as well as anaerobes. Acceptable antimicrobial regimens are outlined in Antibiotics in Pelvic Surgery, Therapeutic Role.

Special Issues Related to Specific Organs

Postoperative gynecologic infections. Pelvic cellulitis is the most common pelvic infection after hysterectomy and develops when the inflammatory response is not confined to the vagina and extends into contiguous pelvic soft tissues. Lower abdominal tenderness with pelvic and back pain and associated fever are the hallmarks. Examination reveals marked tenderness and induration in the infected area, but no fluctuant mass on pelvic examination. Treatment consists of vigorous systemic antibiotic therapy tailored toward treatment of gram-negative enterobacteriacae and anaerobes, particularly *Bacteroides* species. Monotherapy with a second- or third-

generation cephalosporin is appropriate in patients who are not critically ill. In patients in whom monotherapy is not an option, therapy with an aminoglycoside, a third-generation cephalosporin, or aztreonam in combination with metronidazole is effective. Therapy should be continued until patients remain afebrile for 48 hours with resolution of leukocytosis and pain.

In patients who do not respond to therapy or in whom a palpable fullness is appreciated at the vaginal cuff on examination, a diagnosis of cuff abscess is suspected. This often represents an infected hematoma and responds readily to drainage by digital palpation or needle aspiration.

Septic pelvic thrombophlebitis is a rare, late-presenting infectious complication after pelvic surgery. It is a diagnosis of exclusion, made after all other infectious sources have been ruled out in a patient who has been febrile but has not responded to antibiotics. A hectic fever curve and constant tachycardia are characteristic, and physical examination may be unimpressive. Diagnostic studies such as ultrasound and computed tomography (CT) are negative. Treatment with heparin for 7–10 days yields a dramatic response. In addition, antibiotic therapy effective against *Bacteroides* species is indicated. Long-term anticoagulation with warfarin is reserved for patients with associated pulmonary embolus.

Colorectal causes of pelvic infections. *Diverticulitis* in the absence of systemic signs and symptoms can usually be managed on an outpatient basis with the combination of a low-residue diet and a broad-spectrum oral antibiotic (doxycycline, tetracycline, cephalosporin) for 10 days. Patients whose condition worsens with outpatient therapy, or who present with severe signs and symptoms including localized pain or localized peritonitis, should undergo hospitalization. Treatment of these patients consists of bowel rest, hydration, and systemic antibiotic therapy aimed at covering enteric flora. Single-agent therapy with a second-generation cephalosporin (cefoxitin, cefotetan) or one of the extended-spectrum penicillins (ampicillin/sulbactam, ticarcillin/clavulanate) is adequate. Combination therapy using an agent that provides facultative coverage (aztreonam, cefotaxime, ceftriaxone) with an agent that provides anaerobic coverage (metronidazole) also yields good results. Improvement is usually seen within 48 hours, manifested by decreased tenderness and resolution of leukocytosis. Persistent leukocytosis and fevers may represent the presence of an abscess. This diagnosis is best confirmed by CT scan. If an abscess is seen, percutaneous drainage is performed, if possible, allowing for resolution of the inflammatory process. An elective, one-staged operative procedure (resection and primary anastomosis) can then be performed. For patients in whom percutaneous drainage is not an option, or in patients who present with free perforation, operative drainage and resection with Hartmann's procedure or resection with primary anastamosis and proximal stoma is indicated. Simple proximal diversion with drainage, but without resection of diseased bowel, is not prudent because this does not eliminate the source of continued fecal soiling and also subjects the patient to two additional surgical procedures. Systemic antibiotics should be continued until patients are free of systemic signs and symptoms of infection.

Perforated colon cancers present a diagnostic dilemma. Right-sided perforated cancers can be easily confused with acute appendicitis, whereas left-sided perforated cancers are very difficult to distinguish from diverticulitis. If there is evidence of free perforation, exploration should be undertaken. The diagnosis of a perforated cancer is usually evident at laparotomy. Resection of disease with a Hartmann's procedure (end-ileostomy with mucus fistula for right-sided perforations) or primary anastomosis with a protecting colostomy should be performed. As in diverticulitis, patients with localized left-sided peritonitis typically undergo medical management and only require surgery when they do not respond to medical management or develop an abscess not amenable to percutaneous drainage. For this reason, patients should undergo evaluation with flexible endoscopy or radiographic studies if, after the acute process has resolved, the diagnosis is still in question. This lessens the chances of a missed diagnosis of colon cancer. Endoscopy and barium contrast studies should, in general, not be performed during an acute episode of diverticulitis. Antibiotic management for perforated colon cancers is much the same as that for diverticulitis. Perforated colon cancers carry a poorer prognosis with a higher risk of local recurrence, because the availability of such tumors are not often recognized if the lesion is promptly resected as part of staged therapy.

Anastomotic leaks are recognized after the fifth postoperative day according to the signs and symptoms of intra-abdominal or pelvic abscess. The more distal the anastomosis, the higher its potential for leaking. Rectal anastomoses show a leak radiographically in 20% of cases and clinically in 5% of cases. Intraperitoneal leaking requires takedown of the anastomosis and drainage of infection with proximal diversion of the fecal stream. Rectal anastomoses are also best treated by proximal diversion and pelvic drainage, unless confined or in a well patient with functioning bowel. Antibiotics serve as an adjunct to drainage and diversion.

SUMMARY

The value of prophylactic antibiotics in reducing perioperative infectious complications has been a major hallmark in surgical papers over the past 30 years. Surgical prophylaxis is indicated for clean-contaminated surgical procedures in which there is minimal spillage of contents

contained within a mucosal surface and for procedures in which prosthetic materials are being implanted. It is in these procedures that the risk of infection associated with the procedure outweighs the possible detrimental effects from antibiotic use. Antimicrobial agents chosen for prophylaxis should be safe and have an antimicrobial spectrum that is appropriate for the procedure. For these agents to be effective, they should be present in the wound in adequate levels at and throughout the period of contamination, requiring that they be administered 20–30 minutes prior to incision and be readministered at every drug half-life. To prevent the emergence of resistant organisms, these agents should have a relatively narrow spectrum and should be continued for no longer than the duration of the operative procedure, unless prosthetic materials are used. The use of antibiotics for procedures in which there is already established infection or in which there is gross spillage of mucosal contents is deemed therapeutic.

There is a definite role for antibiotics—both prophylactic and therapeutic—in pelvic surgery because of the multiple mucosal sources of potential contamination. Prophylactic antibiotics are indicated for all colorectal procedures, for all vaginal hysterectomy patients and certain groups of patients undergoing abdominal hysterectomy, and for patients with UTIs undergoing urologic procedures. Infections present prior to elective procedures in the pelvis should be eradicated before surgery in order to decrease infectious complications.

Despite the use of prophylactic antibiotics, infectious complications still arise after pelvic surgery. The organisms responsible for these complications consist of the local microflora of the colon and female reproductive tract. Appropriate management of these infections requires the drainage of infectious collections and the institution of antibiotics, in that order. The choice of antibiotics should be based on a knowledge of usual pathogens and on the results of appropriate cultures. Sources of continuous seeding have to be drained, diverted, and/or resected. Systemic antibiotics should be of a broad enough spectrum to cover aerobic and anaerobic enteric organisms and cannot, nor should be, expected to be effective in the absence of adequate drainage.

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